JACC Vol. 14, No. 7
December 1989:1645–50

Percutaneous Transluminal Angioplasty of Saphenous Vein Graft Stenosis: Long-Term Follow-Up

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Percutaneous transluminal angioplasty was used to treat 101 patients with saphenous vein bypass graft stenosis at a mean of 50.1 months (range 2 to 196) after coronary artery bypass surgery. The patients presented between March 1981 and April 1987. A total of 107 saphenous vein grafts were dilated at 117 sites.

The primary success rate was 91.8%. The incidence of cardiac complications was 7.1%. There were no cardiac complications in 53 patients with grafts implanted <36 months before angioplasty (Group 1). The 48 patients with grafts implanted for >36 months (Group 2) had a 12.5% incidence rate of myocardial infarction, a 4% incidence rate of emergent bypass surgery and a 4% incidence rate of death for an overall cardiac complication rate of 14.9% ($p < 0.01$).

Follow-up was obtained at a mean of 16.8 ± 13.9 months (range 1 to 54) in 87 patients (97% of successful cases). Repeat coronary angiography was performed in 49 patients and revealed restenosis in 30 patients (61.2%), with no difference in recurrence rates for proximal, mid or distal graft sites. Clinical recurrence (defined as recurrence of symptoms, myocardial infarction, repeat angioplasty, surgery or death) was 33.1% for Group 1 patients and 64.1% for Group 2 patients ($p < 0.01$).

The complication and recurrence rates of saphenous vein graft angiography are significantly higher when performed for late (>36 months) vein graft failure. All therapeutic options should be carefully examined before proceeding with angioplasty for saphenous vein graft stenosis in this type of patient.

(J Am Coll Cardiol 1989;14:1645–50)

The performance of the first saphenous vein coronary artery graft by Favaloro (1) in 1967 dramatically altered the treatment of coronary artery disease. Serial angiographic studies have revealed, however, that graft patency at 1 year is only 70% to 85% (2–4), and that there is an annual graft attrition rate of 1% to 3% per year until years 5 to 7 when vein graft occlusion increases because of late atherosclerosis (2–7).

The average time to recurrence of anginal symptoms after operation is approximately 2.5 years for all patients and as little as 17 months for those presenting with graft failure (8). Initially, the options for therapy were either medical therapy with its lower incidence of symptom relief or repeat coronary artery bypass grafting with its attendant increased risks (8–11).

The introduction of percutaneous transluminal coronary angioplasty by Gruentzig et al. (12) in 1977 presented cardiologists with another option for therapy in the patient with recurrent angina after coronary artery surgery. The use of this technique in patients with prior coronary artery bypass grafting has been described in several recent reports (13–19). This report describes the results of angioplasty of coronary artery bypass grafts at the Cleveland Clinic Foundation over a 6 year period from 1981 to 1987.

Methods

Study patients. A retrospective review was undertaken for all cases of percutaneous transluminal angioplasty of saphenous vein grafts performed at the Cleveland Clinic Foundation during the 73 month period between March 1981 and April 1987. Clinical information at the time of initial presentation and data obtained at the time of the procedure were recorded on standard forms by a physician. Angiographic measurement of vessel stenosis was performed by using mechanical calipers and reported as the average of two orthogonal projections.

Angioplasty of a saphenous vein graft was performed in

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Manuscript received February 27, 1989; revised manuscript received June 14, 1989, accepted June 29, 1989.

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0735-1097/89/$3.50

101 patients. Clinical follow-up data were obtained for 87 (96.7%) of 90 successful elective procedures, with three patients lost to follow-up. Charts of all 87 patients were reviewed. Telephone contact was made with patients, families or referring physicians. They were questioned as to recurrence of symptoms or hospitalizations for angina, congestive heart failure or myocardial infarction. The families or physicians, or both, of deceased patients were interviewed in an effort to ascertain cause of death. Autopsy results were obtained when available.

Most of the repeat catheterization procedures were performed in our laboratory. Results of outside studies were obtained for review. All patients were assessed at a minimum of 6 months after angioplasty unless clinical conditions warranted earlier evaluation.

Angioplasty technique. In all cases, percutaneous transluminal angioplasty was performed by means of the femoral approach, with a technique similar to that described elsewhere (20,21). All patients received aspirin or aspirin and dipyridamole 12 to 24 h before the procedure. Calcium channel blockers have also routinely been given since 1983. Nitrates and beta-adrenergic blockers were continued if clinically indicated.

Definitions. Diabetes mellitus was defined as elevated serum glucose levels requiring pharmacologic treatment. Elevated cholesterol was defined as a total serum cholesterol >240 mg/dl. Smoking history was considered positive if there was a >10 pack-year history.

Complications were defined according to the National Heart, Lung, and Blood Institute definitions (22) as follows. Myocardial infarction was diagnosed by the presence of two of the three following criteria: prolonged angina, electrocardiographic criteria for infarction using the Minnesota code (23) and elevation of creatine kinase or creatine kinase MB isoenzyme to more than three times normal (upper limits of normal 180 IU/liter and 4%, respectively). *Emergency surgery* was defined as the need for an urgent operation as a direct result of complications from the procedure. *A central nervous system event* was recorded if a transient or persistent neurologic event occurred. *Death* was considered a complication if it occurred before hospital discharge. *Symptomatic status* was based upon the Canadian Cardiovascular Society functional classification (24).

Statistical analysis. Tests for mean differences were performed with the two-tailed Student's *t* test. Two way tables were developed for categoric variables. Chi-square or Fisher's exact test was used depending on expected cell frequencies.

Results

Patient profiles (Table 1). Percutaneous transluminal angioplasty of saphenous vein bypass grafts was attempted in 101 patients. Ninety-eight procedures were elective and three were performed emergently for acute myocardial infarction. The grafts dilated included 38 to the right coronary artery, 32 to the left circumflex artery and 37 to the left anterior descending artery. Of the 17 patients who had angioplasty at more than one site, 10 had dilation of a single site in two different grafts, 2 had dilation of a graft and a native coronary artery and 5 had dilation of two sites in a single graft.

Table 1. Clinical Profile of 101 Patients

Mean age (yr)	59.9
Female (%)	18.8
Time after surgery (months)	
Mean	50.2 ± 49.1
Range (months)	2 to 196
Diabetes mellitus (%)	13.9
Hypertension (%)	55.4
Hypercholesterolemia (%)	26.3
History of tobacco use (%)	75.0
Canadian Heart Association functional class (%)	
I	5.0
II	24.8
III	42.6
IV	27.7
Elective procedures (no.)	98
Total vein grafts (no.)	107
Total sites dilated (no.)	117
Single site (no.)	83
Two sites (no.)	17

Patients undergoing native vessel angioplasty by means of a saphenous vein graft conduit but without bypass graft dilation were not included in this analysis. Patients undergoing internal thoracic artery graft angioplasty were also not included.

Initial procedure (Table 2). A successful procedure was defined as a stenosis reduction >20% with residual stenosis of ≤50% with no complications requiring coronary artery bypass surgery or resulting in death. This was achieved in 90 (91.8%) of 98 elective procedures and 98 (90%) of 109 grafts. Dilations were successful in 47 (88.7%) of 53 proximal graft lesions, 24 (100%) of 24 lesions in the body of the graft and 28 (93.3%) of 30 distal graft lesions (p = NS).

Procedural complications. There were five patients in whom the lesion could not be dilated. Three of these were

Table 2. Primary Results in 98 Cases of Elective Vein Graft Angioplasty

Success (%)	91.8 (90)
Failure (%)	
Medical therapy (%)	3.1 (3)
Elective bypass surgery (%)	1.0 (1)
Emergent bypass surgery (%)	2.0 (2)
Death (%)	2.0 (2)

Values in parentheses indicate number of patients.

subsequently treated medically, one underwent elective bypass surgery and one required emergent bypass surgery and sustained an inferior wall myocardial infarction. Major cardiac events (myocardial infarction, emergency surgery or death) occurred in seven patients (7.1%). One patient required emergent bypass surgery and sustained an anterior infarction after dissection of a vein graft to the left anterior descending artery. Three patients had angiographically successful dilation of the vein graft, but sustained nontransmural myocardial infarction; there was angiographic documentation of distal embolization in two of these patients. There were no episodes of acute occlusion of the grafts dilated in the study patients.

There were two in-hospital deaths. One occurred in a 72 year old man who presented 72 months after operation with recent progression of anginal symptoms. He was found to have an occlusion of the vein graft to the left anterior descending artery at the proximal site. This was successfully opened, but subsequently thrombosed and could not be reopened. The patient had a cerebrovascular accident after the procedure, developed acute renal failure and died 1 month later.

The second death occurred in a 72 year old man 187 months after his bypass surgery. He presented with Canadian Heart Association functional class IV symptoms and was found to have a 79% stenosis at the distal anastomotic site of a vein graft to the left anterior descending artery; he was not considered a surgical candidate because of two prior coronary revascularization procedures. The patient had angiographic evidence of arterial embolism at the time of angioplasty. He died 1 week later. Postmortem examination revealed evidence of multiple embolic myocardial infarcts.

Early versus late vein graft angioplasty (Table 3). The patients were classified into two groups based on the age of the graft. There were 53 patients (52.5%) who had surgery ≤36 months before angioplasty was performed (Group 1). There were 48 patients (47.5%) who had surgery >36 months before angioplasty (Group 2). The groups were well matched for coronary risk factors, symptom and lesion location. Analysis showed no difference between the groups in terms of lesion configuration, number and duration of inflations and balloon to vein graft ratio during angioplasty. After the procedure, there was no difference in intimal dissection between the two groups (9.2% in Group 1 versus 14.9% in Group 2, p = NS). Residual stenosis, however, was significantly greater in the Group 2 patients (Fig. 1).

All cardiac complications occurred in the patients with late vein graft stenosis (Fig. 2). These patients had a 12.5% incidence rate of myocardial infarction, a 4% incidence of emergent bypass surgery, and a 4% mortality.

Follow-up. Eighty-seven of the 90 patients with successful angioplasty were followed-up for an average of 16.8 ± 13.9 months (range 1 to 54). Cardiac catheterization was performed in 49 patients (56.3%). An additional 17 patients (19.5%) had a stress test performed at 16.1 ± 3.4 months (mean ± SD) after the procedure. The remaining 21 patients (24.2%) were followed up clinically.

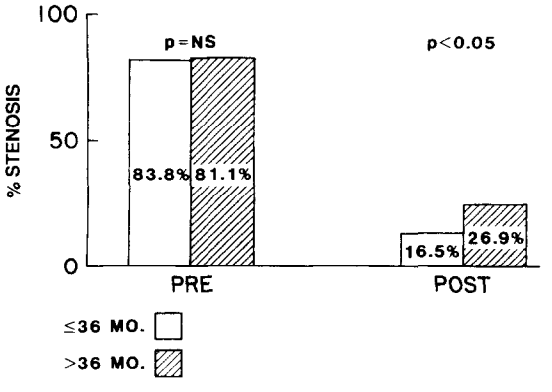
Table 3. Clinical Profile Based on Graft Age in 101 Patients

	Group 1 (≤36 months)	Group 2 (>36 months)	p Value
Patients (no.)	53	48	NS
Mean age (yr)	59.6	60.2	NS
Female (%)	22.6 (12)	14.6 (7)	NS
Time after surgery (months ± SD)	11.0 ± 9.4	91.8 ± 38.7	0.0001
Diabetes mellitus (%)	7.6 (4)	20.8 (10)	0.05
Hypertension (%)	54.7 (29)	56.3 (27)	NS
Hypercholesterolemia (%)	26.0 (13)	26.7 (12)	NS
History of smoking (%)	73.2 (38)	77.1 (37)	NS
Functional anginal class (%)			
I	1.9 (1)	8.3 (4)	NS
II	24.5 (13)	25.0 (12)	NS
III	45.3 (24)	39.6 (19)	NS
IV	28.3 (15)	27.1 (13)	NS
Vessel grafted			
Right coronary artery (%)	41.8 (23)	28.8 (15)	NS
Left anterior descending (%)	32.7 (18)	36.5 (19)	NS
Left circumflex artery (%)	25.4 (14)	34.6 (18)	NS
Graft lesion dilated			
Proximal (%)	46.3 (25)	52.8 (28)	NS
Body (%)	22.2 (12)	22.6 (12)	NS
Distal (%)	31.5 (17)	24.6 (13)	NS
Patients with >1 vessel PTCA (%)	11.3 (6)	10.4 (5)	NS
Repeat catheterization (%)	49.0 (26)	47.9 (23)	NS

Values in parentheses indicate total number of patients. PTCA = percutaneous transluminal coronary angioplasty.

Recurrence was classified angiographically as stenosis of >50% on repeat catheterization. If no repeat catheterization was performed, additional criteria for clinical recurrence were an abnormal stress test or recurrence of the patient's initial symptoms, or both, with deterioration to Canadian

Figure 1. Percent luminal stenosis before (PRE) (n = 101) and after (POST) (n = 48) vein graft angioplasty based on graft age.



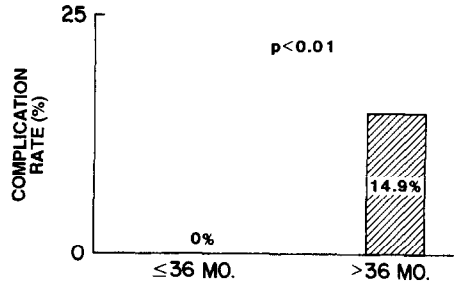


Figure 2. Complication rate of vein graft angioplasty for Group 1 (graft age ≤36 months) (n = 53) compared with Group 2 (graft age >36 months) (n = 48).

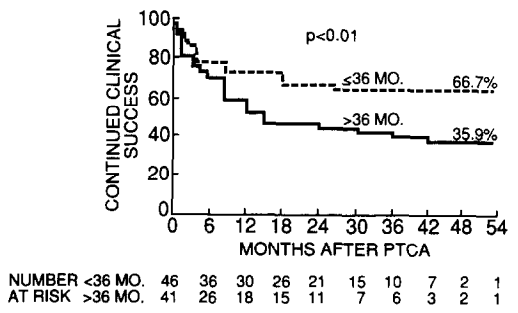


Figure 3. Percent survival without any cardiac event (myocardial infarction, repeat angioplasty, surgery, death or symptom recurrence) for all 87 patients based on graft age (≤ or >36 months). PTCA = percutaneous transluminal coronary angioplasty.

Heart functional class III or IV at any point during the follow-up period. If the patient died during the follow-up period and the death was either sudden or of known cardiac origin, the patient was also classified as having had a recurrence. Data were analyzed for the entire group and for a comparison of Groups 1 and 2 (Table 4).

Graft restenosis. Angiographic recurrence was found in 30 (61.2%) of 49 patients at the time of catheterization. An additional two patients had a positive stress test at 1 and 26 months after angioplasty, respectively, but were treated medically. Nine additional patients were classified as having a recurrence on the basis of history. Five of these patients had either recurrence of symptoms, myocardial infarction or cardiac death within 6 months of the procedure. Angiographic or clinical recurrence, or both, for the entire group was observed in 41 patients (47.1%).

Recurrence rates were evaluated for each site of stenosis. There was no significant difference in the rate of recurrence based on the graft site dilated. Angiographic or clinical recurrence, or both, occurred in 21 (50%) of 42 proximal lesions, 9 (45%) of 20 lesions of the body of the graft and 10 (42%) of 24 distal lesions dilated.

The recurrence rate for the Group 1 patients (early graft failure) was compared with that for the Group 2 patients (late graft failure). Forty-two percent of Group 1 patients had angiographic recurrence compared with 83% of Group 2 patients (p = 0.01). Clinical recurrence, defined as a cardiac event (that is, myocardial infarction, repeat angioplasty or bypass surgery or death) or progression to Canadian Heart Association functional class III or IV, was 33.3% for Group 1 and 64.1% for Group 2 (p < 0.01) (Fig. 3).

Table 4. Follow-up Data Based on Graft Age in 87 Patients

	Group 1 (<36 months)	Group 2 (>36 months)	p Value
Patients (no.)	48	39	NS
Time of follow-up (months ± SD)	19.1 ± 14.5	14.0 ± 12.7	NS
Functional class I or II and free from angiographic recurrence of late cardiac event (%)	66.7	35.9	0.004
Angiographic recurrence (%)	42.3	82.6	<0.01
Myocardial infarction (%)	12.1	28.2	0.06
Repeat bypass surgery (%)	14.0	26.8	NS
Repeat angioplasty (%)	10.0	12.8	NS
Death (%)	12.0	10.5	NS

Discussion

Primary results and complications. These data suggest that although saphenous vein graft angioplasty can be performed with a good primary success rate (92% over the time of this study), there are a few caveats. The overall complication rate was 7.1%, with a 5.9% incidence of myocardial infarction. Three of the six myocardial infarcts were the result of distal embolization of the atherosclerotic material at the time of angioplasty. These findings are in agreement with that reported by Douglas et al. (18), and are slightly higher than reported in other series (19,25).

Graft age and primary results. The study cohort classified into two groups based on the age of the vein graft. There is good evidence (26–29) to support that in the absence of hyperlipidemia, it is unusual to find organized atherosclerotic plaques in grafts implanted <36 months. For this reason, the patients who had coronary artery surgery within the previous 36 months (Group 1) were compared with those who were >36 months from the time of their surgery (Group 2). Most baseline characteristics of the groups were well matched. However, Group 2 had a significantly greater proportion of diabetic patients (20.8 versus 7.6% for Group 1, p = 0.05).

The complication rate was significantly higher in Group 2. Additionally, even though the groups were matched for vessels bypassed and distribution of lesions among the proximal, distal and mid portion of the grafts, there was a significant difference in the residual stenosis after angioplasty in the Group 2 patients. These findings may be due in

part to the different pathologic process involved in early compared with late graft failure (25–29).

Recurrence. Recurrence rates were assessed on the basis of the angiographic findings. This method is likely to be unfavorably weighted with those patients who had recurrence because they would more likely be symptomatic, thus leading to a repeat catheterization. For this reason, recurrence was also assessed on the basis of clinical data. The angiographic recurrence rate was 61.2% for the 49 patients who had cardiac catheterization. The clinical recurrence rate was only slightly lower at 47.1% for the entire group. When the study cohort was divided on the basis of graft age, there was a significantly higher rate of angiographic and clinical recurrence with the older vein grafts.

Factors influencing recurrence. The different restenosis rates in patients with early versus late vein graft stenosis might be explained by the different pathologic processes resulting in graft stenosis in these two groups (26–29). Unfortunately, a confounding factor that makes a firm conclusion difficult is the higher incidence of diabetic patients in Group 2. This may have played a part in the increased restenosis rate in this group because five of the seven diabetic patients who were followed up had recurrent stenosis.

The overall rate of angiographic recurrence is significantly higher than that in any studies reported thus far (15,17,19,30–32) and is also higher than the 30% recurrence rate reported earlier from this institution (33) in 43 patients who were treated during the earlier years of angioplasty in the current series. A possible explanation for this is the length of the follow-up period. The several reported series (19,31,33) had an average follow-up period of ≤8 months compared with 16 months in the current study. The most recent results of the series reported by Douglas et al. (32) have been presented in an abstract form and only state the range of follow-up of 1 to 8 years, making any further time comparison difficult.

An additional factor to explain our high recurrence rates may be the age of the graft at the time of the angioplasty procedure. An earlier report by Douglas et al. (14) reported an excellent restenosis rate of only 12% at the distal anastomosis during an average follow-up period of 10 months. Of interest, 74% of those patients had their angioplasty performed within 1 year of bypass surgery. By comparison, the angiographic recurrence rate in our series for all patients who had dilation of a distal anastomotic lesion was 50%, but for the Group 1 patients, the recurrence rate was 33%. Taking data from both studies, it is clear that the best use of angioplasty in vein graft stenosis is in the patient recently operated on with a distal anastomotic site stenosis.

Our series also failed to show any difference in restenosis rates when proximal, body and distal graft sites were compared. This is in agreement with the series by Cote et al. (19). However, other studies (15,17,31,32) showed significantly lower rates of recurrence in the distal anastomotic sites.

Conclusions. Although saphenous vein graft angioplasty can be carried out with a primary success rate of 92%, on the basis of our findings, there is a 6% likelihood of myocardial infarction, a 2% likelihood of emergent coronary bypass surgery and a 2% mortality rate. However, all of these events occurred after angioplasty on grafts implanted >36 months after operation, resulting in a complication rate of 14.9% in this group. Additionally, the recurrence rate for these older grafts was 64% compared with 33% for grafts implanted <36 months after operation.

In light of these high complication and recurrence rates, all therapeutic options should be carefully considered for the patient with late vein graft failure. These could include continued medical therapy for the mildly symptomatic patient, angioplasty of the native coronary circulation where possible or repeat coronary bypass surgery.

References

1. Favaloro RG. Saphenous vein autograft replacement of severe segmental coronary artery occlusion: operative technique. Ann Thorac Surg 1968; 5:334–9.

2. Seides SF, Borer JS, Kent KM, Rosing DR, McIntosh CL, Epstein SE. Long-term anatomic fate of coronary artery bypass grafts and functional status of patients five years after operation. N Engl J Med 1978;298: 1213–7.

3. Grondin CM, Campeau L, Lesperance J, Enjalbert M, Bourassa MG. Comparison of late changes in internal mammary artery and saphenous vein grafts in two consecutive series of patients 10 years after operation. Circulation 1984;70(suppl I):I-208–12.

4. Brower RW, Laird-Meeter K, Serruys PW, Meester GT, Hugenholtz PG. Long term follow-up after coronary artery bypass graft surgery. Br Heart J 1983;50:42–7.

5. Guthaner DF, Robert EW, Alderman EL, Wexler L. Long-term serial angiographic studies after coronary artery bypass surgery. Circulation 1979;60:250–9.

6. Campeau L, Enjalbert M, Lesperance J, et al. The relation of risk factors to the development of atherosclerosis in saphenous-vein bypass grafts and the progression of disease in the native circulation. N Engl J Med 1984;311:1329–32.

7. Lytle BW, Loop FD, Cosgrove DM, Ratliff NB, Easley K, Taylor PC. Long-term (5 to 12 years) serial studies of internal mammary artery and saphenous vein coronary bypass grafts. J Thorac Cardiovasc Surg 1985; 89:248–58.

8. Loop FD, Cosgrove DM, Kramer JR, et al. Late clinical and arteriographic results in 500 coronary artery reoperations. J Thorac Cardiovasc Surg 1981;81:675–85.

9. Loop FD, Thurer RL, Lytle BW, Cosgrove DM. Reoperation for myocardial revascularization. World J Surg 1978;2:719–29.

10. Norwood WI, Cohn LH, Collins JJ. Results of reoperations for recurrent angina pectoris. Ann Thorac Surg 1977;23:9–13.

11. Krause AH, Page US, Bigelow JC, Okies JE, Dunlap SF. Reoperation in symptomatic patients after direct coronary artery revascularization. J Thorac Cardiovasc Surg 1978;75:499–504.

12. Gruentzig AR, Myler RK, Hanna ES, Turina MI. Coronary transluminal angioplasty (abstr). Circulation 1977;55–56(suppl III):III-84.

13. Ford WB, Wholey MH, Zikria EA, Somadani SR, Sullivan ME. Percutaneous transluminal dilation of aortocoronary saphenous vein bypass grafts. Chest 1981;5:529–35.

14. Douglas JS, Gruentzig AR, King SB, et al. Percutaneous transluminal coronary angioplasty in patients with prior coronary bypass surgery. J Am Coll Cardiol 1983;2:745–54.

15. Dorros G, Johnson WD, Tector AJ, Schmahl TM, Kalush SL, Janke L. Percutaneous transluminal coronary angioplasty in patients with prior coronary artery bypass grafting. J Thorac Cardiovasc Surg 1984;87:17–26.

16. Marquis JF, Schwartz L, Brown R, et al. Percutaneous transluminal angioplasty of coronary saphenous vein bypass grafts. Can J Surg 1985; 28:335–7.

17. Reeder GS, Bresnahan JF, Holmes DR, et al. Angioplasty for aortocoronary bypass graft stenosis. Mayo Clin Proc 1986;61:14–9.

18. Douglas J, Robinson K, Schlumpf M. Percutaneous transluminal angioplasty in aortocoronary venous graft stenosis: immediate results and complications (abstr). Circulation 1986;74(suppl II):II-363.

19. Cote G, Myler RK, Stertzer SH, et al. Percutaneous transluminal angioplasty of stenotic coronary artery bypass grafts: 5 years' experience. J Am Coll Cardiol 1987;9:8–17.

20. Gruentzig AR, Senning A, Siegenthaler WE. Nonoperative dilatation of coronary-artery stenosis. N Engl J Med 1979;301:61–8.

21. Hollman J. Percutaneous transluminal angioplasty in patients with failed coronary bypass grafts. In: Jang GD, ed. Angioplasty. New York: McGraw-Hill, 1986:346–56.

22. Dorros G, Cowley MJ, Simpson J, et al. Percutaneous transluminal coronary angioplasty: report of complications from the National Heart, Lung, and Blood Institute PTCA Registry. Circulation 1983;67:723–30.

23. Blackburn H, Keys A, Simonson E, Rautaharju P, Pursar S. The electrocardiogram in population studies: a classification system. Circulation 1960;21:1160–75.

24. Campeau L. Grading of angina pectoris (letter). Circulation 1975;54:522.

25. Saber RS, Edwards ND, Holmes DR, et al. Balloon angioplasty of aortocoronary saphenous vein bypass grafts: a histopathologic study of six grafts from five patients, with emphasis on restenosis and embolic complications. J Am Coll Cardiol 1988;12:1501–9.

26. Smith SH, Geer JC. Morphology of saphenous vein-coronary artery bypass grafts. Arch Pathol Lab Med 1983;107:13–8.

27. Waller BF, Rothbaum DA, Gorfinkel HJ, Ulbright TM, Linnemeier TJ, Berger SM. Morphologic observations after percutaneous transluminal balloon angioplasty of early and late aortocoronary saphenous vein bypass grafts. J Am Coll Cardiol 1984;4:784–92.

28. Batayias GE, Barboriak JJ, Korns ME, Pintar K. The spectrum of pathologic changes in aortocoronary saphenous vein grafts. Circulation 1977;56(suppl II):II-18–22.

29. Lie JT, Lawrie GM, Morris GC. Aortocoronary bypass saphenous vein graft atherosclerosis. Am J Cardiol 1977;40:906–14.

30. Ernst SMPG, van der Feltz TA, Ascoop CAPL, et al. Percutaneous transluminal coronary angioplasty in patients with prior coronary artery bypass grafting. J Thorac Cardiovasc Surg 1987;93:268–75.

31. Block PC, Cowley MJ, Kaltenbach M, Kent KM, Simpson J. Percutaneous angioplasty of stenoses of bypass grafts or of bypass graft anastomotic sites. Am J Cardiol 1984;53:666–8.

32. Douglas J, King S, Roubin G, Schlumpf M. Percutaneous angioplasty of venous aortocoronary graft stenoses: late angiographic and clinical outcome (abstr). Circulation 1986;74(suppl II):II-281.

33. Corbelli J, Franco I, Hollman J, Simpfendorfer C, Galan K. Percutaneous transluminal coronary angioplasty after previous coronary artery bypass surgery. Am J Cardiol 1985;56:398–403.